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DEPARTMENT OF TRANSPORTATION

SOIL MECHANICS
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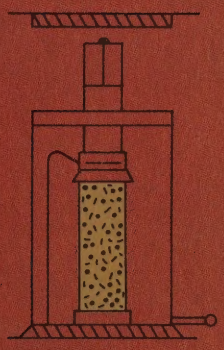

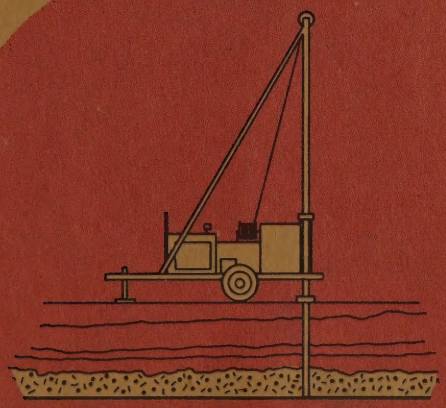

REPORTS ON PROPOSED QUARRY FOR THE PRODUCTION OF CURBING AND CRUSHED STONE AGGREGATE IN MEDINA SANDSTONE FORMATION AT HULBERTON, ORLEANS COUNTY, NEW YORK

MEDINA SANDSTONE QUARRY, INC.,
OPERATOR

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REPORTS ON PROPOSED QUARRY FOR THE PRODUCTION OF CURBING AND CRUSHED STONE AGGREGATE IN MEDINA SANDSTONE FORMATION AT HULBERTON, ORLEANS COUNTY, NEW YORK

MEDINA SANDSTONE QUARRY, INC., OPERATOR

By
Paul H. Bird
Associate Engineering Geologist

Albany, New York
July 31, 1969

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M E M O R A N D U M

November 20, 1968

TO: Wm. P. Hofmann, Director
Bureau of Soil Mechanics

FROM: Paul H. Bird
Associate Engineering Geologist

SUBJECT: Medina Sandstone Curbing

Under date of 4/16/68 George W. McAlpin, Deputy Chief Engineer, requested George Young to submit to the writer a sample of Medina sandstone for the purpose of determining its acceptability for curbing. The location of the source of this sample was unknown. Stone represented by it is considered unacceptable, due to an inferior quality of cementing material and a laminated structure.

It was later decided to make an inspection of curbing being manufactured by The Williams Paving Co., Buffalo, New York, who requested State acceptance. The processing plant, storage yard and quarry of this concern was also inspected. The plant is modern and designed to produce curbing of required size tolerances.

An examination of the stocked curbing and the large blocks received from the quarry indicated an unusually high and uniform quality product for stone from this formation.

The quarry at Hulberton, approximately 50 miles northeast of Buffalo, is being operated in a high class manner. A "course" or "lift" of stone approximately 8 feet thick is used for curb manufacture. Overlying poor quality stone is stripped and wasted. Accompanying photographs illustrate the method of quarrying and appearance of stockpiled curbing.

From previous experience and studies it was known that the durability of Medina sandstone curbing depends almost entirely on the type of natural cementing material that binds the sand grains together. The latter consist almost exclusively of quartz; an extremely durable mineral. Three types of cement have been observed; 1) iron oxide, 2) carbonate, chiefly calcite and 3) quartz. Almost invariably all three types occur in the same specimen; it is the relative proportion that determines the durability of the stone.

Stone in which iron oxide is the principal cementing agent fails rapidly where exposed to weathering and is worthless for any structural use.

Carbonate is rarely the predominant cement, but where it is, the stone is durable.

Stone cemented chiefly by quartz is the most durable type.

The term "cementation" implies a somewhat different process when applied to carbonate and iron oxide cementation on the one hand and to quartz cementation on the other hand. In iron oxide and carbonate cementation the cementing medium simply fills voids between the sand grains and binds them together by the forces of adhesion or cohesion the same as cement paste binds aggregate in concrete.

"Cementation" by quartz is a more complex process. At points where the sand grains are in contact with one another, solution due to pressure takes place. The area of contact is thus enlarged and an interlocking joint developed. Concurrently the quartz that is dissolved is re-deposited in the spaces between the grains and to a more or less extent in crystal continuity with adjacent grains. The end result of this process is a rock composed almost entirely of quartz which will fracture through the original sand grains rather than around them. This process thus may be considered cementation plus welding. Such a rock is technically known as an "orthoquartzite." It is one of the most durable rocks known when exposed to the elements of weathering. Also, with proper equipment it can be split in any direction regardless of stratification as shown in photographs No. 2 and 3.

The evidence visible in the quarry and plant indicated strongly the possibility that the stone produced by The Williams Paving Co. is a true orthoquartzite. The most positive way to prove this is by a study of thin sections. Due to delay in obtaining specimens for thin sections and later by illness this study has been unduly delayed.

Nine thin sections were cut from specimens taken at the bottom and at the top of the "lift" being quarried and at 1-foot intervals in between. A microscopic examination has revealed that the only difference in these sections is a slight variation in grain size. They all represent a true orthoquartzite.

When these rounded sand grains were deposited they were coated with a thin film of red iron oxide, which imparts to the stone its characteristic reddish color. This film is undisturbed in many cases and serves as an outline of the original shape of the grains as shown in the accompanying photomicrograph. At the "welded" junctures it has been dislocated.

It is interesting to note that at the height of the Medina sandstone industry, just previous to the turn of the century, stone from the eastern end of the belt that was actively quarried was considered superior to that from the western end. The Hulberton quarry is near the eastern end.

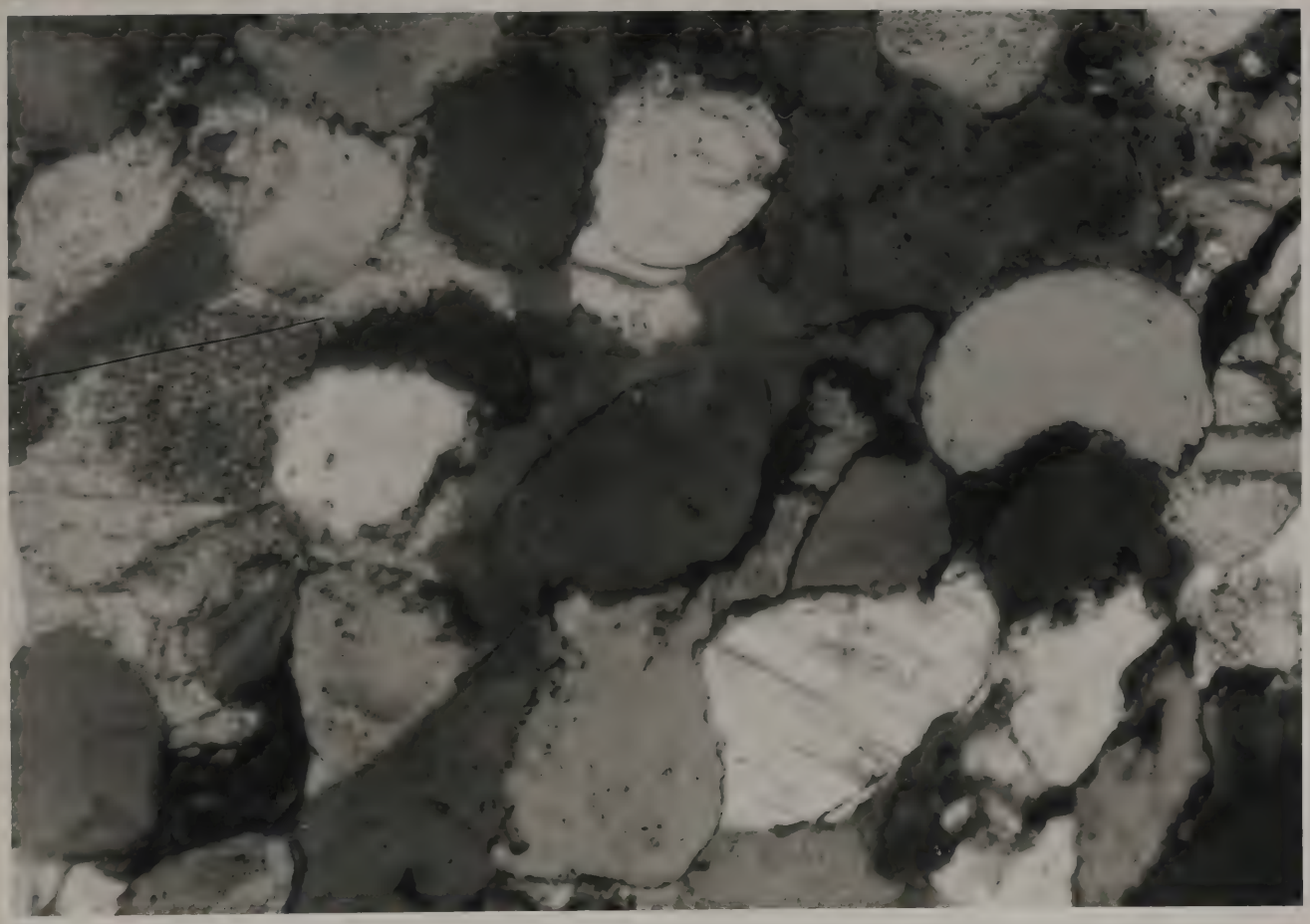
The only deleterious feature observed in the stockpiled curbing was a rare thin band of greenish to white, shale-like material as shown in Photographs No. 2 and 3, and this was seen only in curbing that was rejected by the producer. In fact there is curbing in place in Buffalo that is inferior to much of the rejected curbing in the Williams yard.

This study has led to a confident recommendation that curbing from this producer is of acceptable quality so far as durability is concerned. The following restrictions, however, should be rigidly carried out: 1) stone only from the Hulberton quarry is acceptable; 2) curbing must be free of light colored, clay-like laminae as shown in photographs No. 2 and 3; and 3) only stone from the lift shown in photographs No. 4 and 5 shall be acceptable.

Paul H. Bird

Paul H. Bird
Associate Engineering Geologist

PHB/mvm



Photomicrograph at a magnification of about 150 times illustrating the features of stone from the Hulberton quarry. Taken with crossed polarized light to emphasize the internal structure. All the gray and white grains are quartz. The "pockmarked" grain, center left, is calcite. The real dark gray to black, irregular shaped masses and streaks are red iron oxide.

Note the gray grain of quartz in the center, the original rounded shape of which is shown by a hairline of iron oxide, except at the lower end where solution has destroyed the original shape and "welded" it to the adjacent grain below. The quartz on the outside of the hairline was deposited in an original pore space and is optically continuous with the quartz of the original grain.

PHOTOGRAPH I

Taken in the yard at the Williams plant in Buffalo. The stone comes from the Hulberton quarry in the form of these large blocks.

Note: 1) The irregular bedding which appears vertical in the view; 2) The vertical, light toned streaks near the right hand end. They are parallel to the bedding and composed of a weak clay-like material that weathers rapidly.

PHOTOGRAPH NO. 2

Taken in the Williams yard. The curbing shown here is of inferior quality and is not offered for sale. Taken to show the light colored material in the piece at the end of the hammer handle. This material is deleterious and curbing such as this should not be accepted. The same type of material is present as irregular shaped masses in the two pieces at the left hand side of the view. Note that the piece at the end of the hammer handle is split at an angle to the stratification.

PHOTOGRAPH NO. 3

A view at about true size taken to show a close-up of one of the light colored, weak streaks. This piece also is split at an angle to the bedding.

PHOTOGRAPH NO. 4

A view looking west in the quarry at Hulberton. Taken to show the method of quarrying, by means of line drilling, the "lift" that is used for the manufacture of curbing. Note the irregular bedding as shown by streaks and bands of varying tone. This structure has very little if any influence on the direction in which the stone is split, due to thorough cementation and "welding." For the purpose of splitting it is essentially a solid, isotrophic block of quartz.

PHOTOGRAPH NO. 5

Looking east in the Hulberton quarry. Specimens for thin sections were taken at one-foot intervals from bottom to top in this face. Note that stratification shows very indistinctly, if at all.

REPORT ON MEDINA SANDSTONE QUARRY, INC.

The following report was requested by G. W. McAlpin, Deputy Chief Engineer. Correspondence with the above company should be addressed to: Mr. Vincent S. Hennen, c/o Greater Buffalo Press, 302 Grote Street, Buffalo, New York 14207. The quarry is located in Orleans County about a half mile east of the village of Hulberton and adjacent to the New York Barge Canal on the south.

There is at present an operating quarry on the property, which was formerly operated by Williams Paving Co., Buffalo, New York for the production of curb stone. A report covering this operation was requested by the company to assist in determining State acceptability. This report was submitted to Wm. P. Hofmann, Director, Bureau of Soil Mechanics, under date of November 20, 1968 and forwarded to Mr. McAlpin. This former report is to be considered a part of the present report.

The presently contemplated operation will continue the production of curbing, and, in addition, will include crushed stone aggregate, all subject to State acceptance.

So far as curbing is concerned the restrictions stated in the November 20th report apply to future production, unless it can be established that stone of equal or better quality can be procured from deeper beds.

This present report is based on: 1) the stone being quarried for curbing, 2) a visual examination of split diamond drill cores from seven locations on the property, all drilled to or into the underlying shale, at depths ranging from 37 to 56 feet below the surface, 3) a microscopic study of thin sections from selected specimens, 4) a study of the geologic report submitted to the company by James R. Dunn and Associates dated February 26, 1968, which accompanies this report and 5) an examination on two occasions of fifteen miles of Portland Cement concrete pavement on State Route No. 18 in Orleans County constructed in 1932 in which the coarse aggregate is Medina sandstone. This is considered by far the most important criteria in judging the quality of this stone for crushed aggregate.

According to records on file in the Bureau of Materials and District No. 4, the coarse aggregate for this pavement was produced from spoil that accumulated in connection with the production of dimension stone, curbing, paving blocks, etc. probably 30 or more years prior to the construction of the pavement.

On the north side of the canal and approximately a mile west of the property in question what is most certainly the site of the plant that produced this stone was located, as indicated by the area shown on the record maps and by physical evidence of the former existence of a plant. The spoil at this site is a mixture of overburden soil and stone unsuitable for the products of the original operations. The appearance of the coarse aggregate in the pavement checks with what would be expected in crushed stone from this spoil. In my judgment aggregate produced from the presently proposed quarry operation will be superior to what was produced from the spoil.

The concrete in the pavement of Route 18 is certainly of excellent quality. In fact it is perfect except for an occasional small area of surface scaling, which probably occured soon after construction. There are some areas of fracturing due to foundation failure.

The Dunn report indicates two zones (A and B) based on the cores. The cementing medium in the lower zone (B) consists of slightly more calcite, and concurrently less silica than the upper zone (A). The present curb stone production is from zone (A). In the writer's judgment zone A as represented by the present quarry face and the cores is slightly superior to zone B. It is considered advisable to restrict curb production to zone A at least until the underlying strata of zone B is fully exposed in a quarry face. However, as stated above, it is my opinion that aggregate can be produced from either or both zones that will be superior to the aggregate produced from spoil and used in the pavement of Route 18.

There is one exception to the last statement of the foregoing paragraph. The core from drill hole No. 6 indicates about eleven feet of strata at the top that is strongly laminated and contains a concentration of shaly bands. This type of rock is unsuitable for any proposed purpose. None of it occurs in any of the other cores, but there could be lenses missed by the drill holes. It is therefore suggested that a reasonable degree of quarry control be maintained as operations proceed.

In analyzing test data it is interesting to note that recent magnesium sulphate tests on cores and crushed stone indicate, on the average, failure by State standards, while freeze-thaw and Deval abrasion tests meet State standards.

In summary, the writer considers the excellent durability and resistance to wear and weathering effects of Medina sandstone aggregate overwhelmingly proved by the service record of the 37-year old pavement of Route 18 in Orleans County.

Accompanying this report are a series of photographs and photomicrographs intended to illustrate some of the technical details with a bearing on the quality of Medina sandstone.

Paul H. Bird
Associate Engineering Geologist

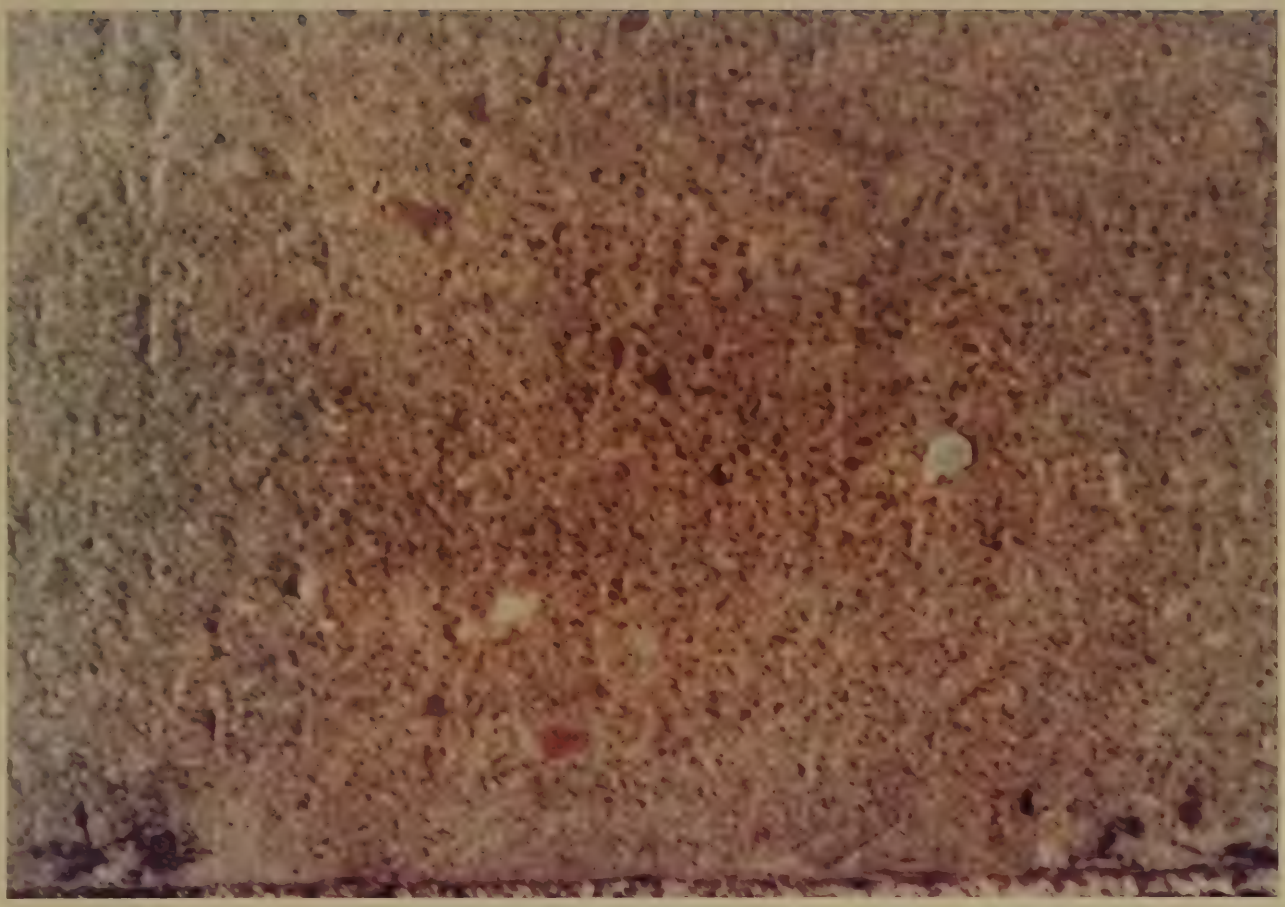
PHB/sas

PHOTOGRAPH NO. 1
(Furnished by James R. Dunn and Associates, Inc.)

The pavement of Route 18 about a mile east of the intersection of Routes 18 and 98. The dark areas are wet spots. The small areas of surface scaling in the foreground are typical of this feature that occur on a small fraction of one percent of the 15-mile pavement.

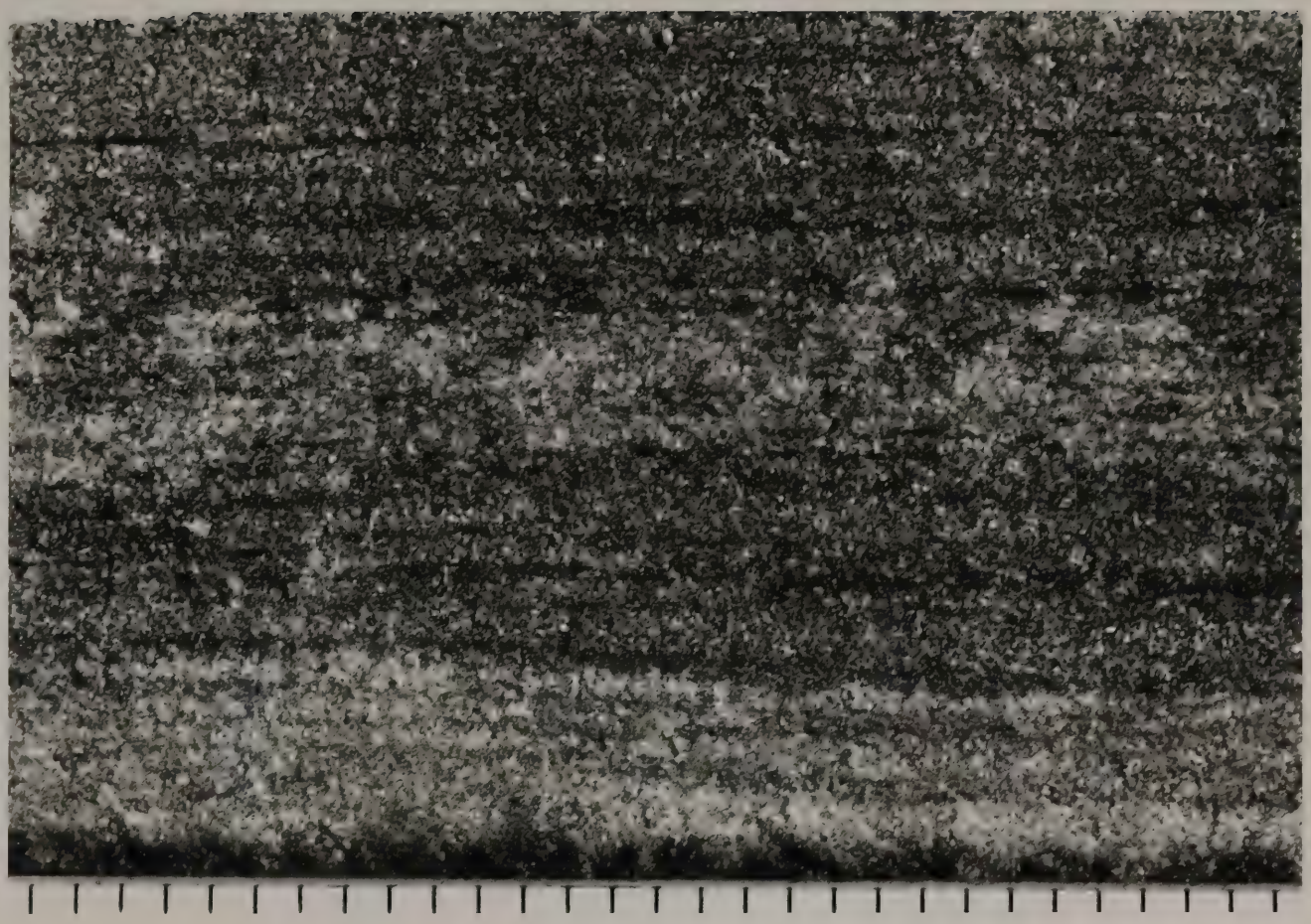
PHOTOGRAPH NO. 2
(Furnished by James R. Dunn and Associates, Inc.)

Another view of the pavement taken five miles east of the intersection of Routes 18 and 98. Note that here, as is the case of most of the 15 miles of this pavement, the highway is raised only slightly or none above the adjacent country. It certainly is not raised enough to assure efficient drainage beneath the pavement.



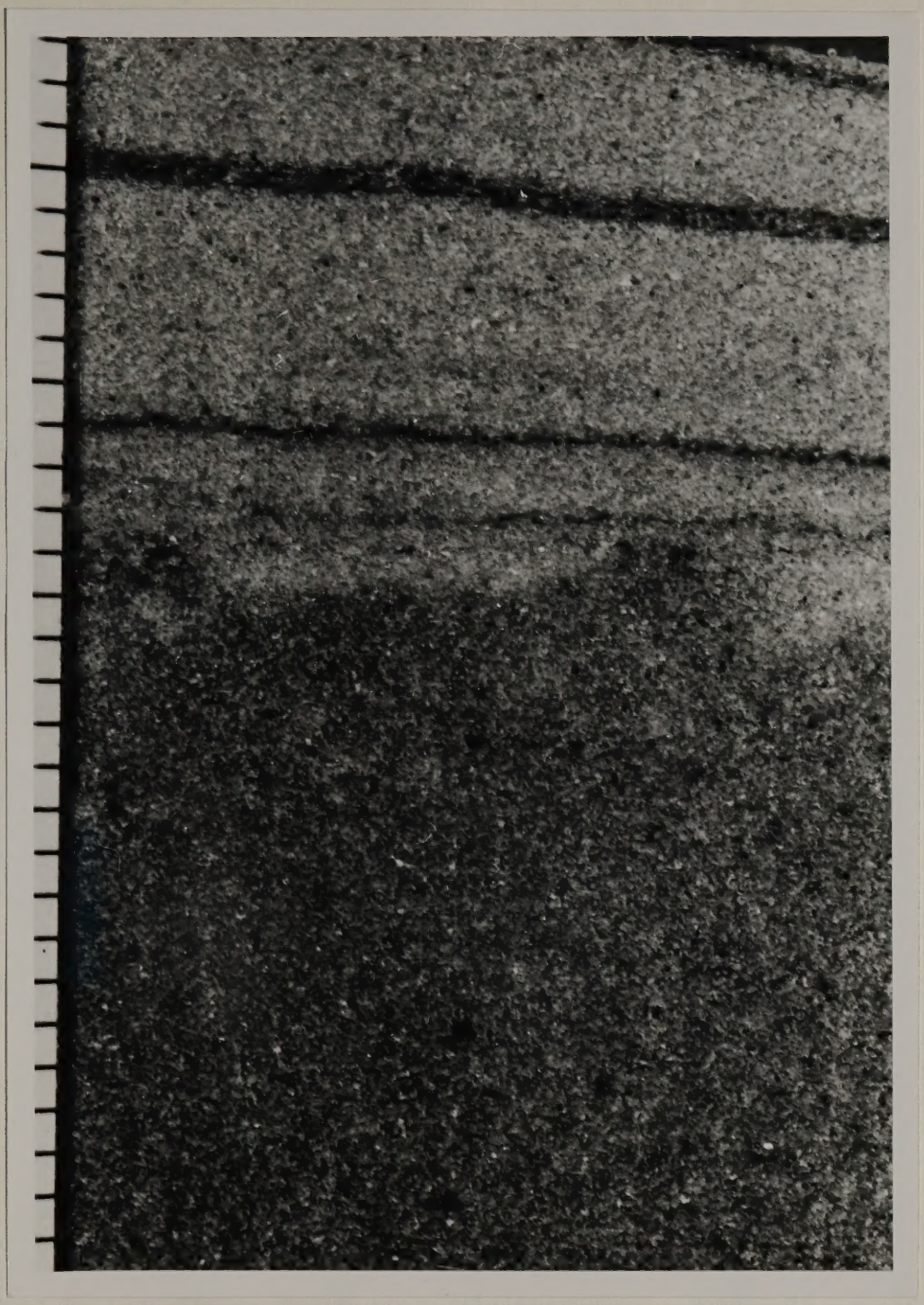
PHOTOGRAPH NO. 3
(Furnished by James R. Dunn and Associates, Inc.)

A close-up showing the texture and average appearance of this 37-year old pavement. The coin is a quarter.



PHOTOGRAPH NO. 4

A macrophotograph of a fractured surface of laminated Medina sandstone. The graduations of the scale are ½mm.(1/50 in.). The light laminae are almost white; the dark ones red. None of this type of rock should be permitted in curbing, but due to the very small amount present will not prove deleterious in crushed aggregate. Compare with the following Photograph No. 5.



PHOTOGRAPH NO. 6 (Graduations ½mm.=1/50")

A macrophotograph showing three types of stone in a smoothly ground surface. The lower half is normal, high quality sandstone. The light toned upper half is a prominently developed "green band" the lighter toned material is greenish-white sandstone. The dark streaks are dark green, fine grained, clay like material. These bands are deleterious in curbing, but too small in amount to cause trouble in aggregate.. In fact the weak clay-like material will probably be lost in crushing and screening.

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